इंटरनेट मानक

Disclosure to Promote the Right To Information

Whereas the Parliament of India has set out to provide a practical regime of right to information for citizens to secure access to information under the control of public authorities, in order to promote transparency and accountability in the working of every public authority, and whereas the attached publication of the Bureau of Indian Standards is of particular interest to the public, particularly disadvantaged communities and those engaged in the pursuit of education and knowledge, the attached public safety standard is made available to promote the timely dissemination of this information in an accurate manner to the public.

“जानने का अधिकार, जीने का अधिकार”
Mazdoor Kisan Shakti Sangathan
“The Right to Information, The Right to Live”

“पुराने को छोड नये के तरफ”
Jawaharlal Nehru
“Step Out From the Old to the New”

IS 9509 (1980): Guide for treatment and disposal of effluents of viscose rayon industry [CHD 32: Environmental Protection and Waste Management]

“ज्ञान से एक नये भारत का निर्माण”
Satyanarayan Gangaram Pitroda
“Invent a New India Using Knowledge”

Act Number 22 of 2005
The Indian Parliament
RIGHT TO INFORMATION

Made Available By
Public.Resource.Org

“ज्ञान एक ऐसा खजाना है जो कभी चुराया नहीं जा सकता है”
Bhartṛhari—Nītiśatakam
“Knowledge is such a treasure which cannot be stolen”

BLANK PAGE

BRUTUM FULMEN

IGNORANTIA JURIS NON EXCUSAT

PROTECTED BY COPYRIGHT

IS : 9509 - 1980
(Reaffirmed 2003)

Indian Standard

GUIDE FOR TREATMENT AND DISPOSAL OF EFFLUENTS OF VISCOSE RAYON INDUSTRY

UDC 628·543 (026) : 677·463

© *Copyright* 1980

INDIAN STANDARDS INSTITUTION
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

Gr 5

Price Rs 8·50

November 1980

Indian Standard

GUIDE FOR TREATMENT AND DISPOSAL OF EFFLUENTS OF VISCOSE RAYON INDUSTRY

Water Sectional Committee, CDC 26

Chairman	*Representing*
Dr T. R. Bhaskaran	Geo-Miller & Co Pvt Ltd, Calcutta
Members	
Shri N. S. Bhairavan	Kerala State Board for the Prevention & Control of Water Pollution, Trivandrum
Shri J. D. Joysingh (*Alternate*)	
Shri A. K. Bhattacharyya	National Test House, Calcutta
Shri K. D. Das (*Alternate*)	
Shri V. M. Bhuchar	National Physical Laboratory (CSIR), New Delhi
Shri Jitendra Rai (*Alternate*)	
Chief Water Analyst, King Institute, Madras	Director of Public Health, Government of Tamil Nadu, Madras
Shri S. K. Chakrabarti	Steel Authority of India Ltd, New Delhi
Shri A. K. Poddar (*Alternate* I)	
Shri A. K. Das (*Alternate* II)	
Shri L. M. Choudhry	Haryana State Board for the Prevention & Control of Water Pollution, Chandigarh
Shri M. L. Prabhakar (*Alternate*)	
Shri A. Durai Raj	Department of Environmental Hygiene (Government of Tamil Nadu), Madras
Shri B. K. Dutta	The Fertilizer (Planning & Development) India Ltd, Sindri
Shri G. S. Ray (*Alternate*)	
Shri P. Ganguly	The Alkali & Chemical Corporation of India Ltd, Calcutta
Shri P. K. Chakravarty (*Alternate*)	
Shri K. L. Ghosh	Regional Research Laboratory (CSIR), Bhubaneshwar
Dr M. I. Gurbaxani	The Tata Iron & Steel Co Ltd, Jamshedpur
Shri Mallinath Jain	Delhi Water Supply & Sewage Disposal Undertaking, New Delhi
Shri K. R. Sahu (*Alternate*)	

(*Continued on page* 2)

© *Copyright* 1980
INDIAN STANDARDS INSTITUTION
This publication is protected under the *Indian Copyright Act* (XIV of 1957) and reproduction in whole or in part by any means except with written permission of the publisher shall be deemed to be an infringement of copyright under the said Act.

(*Continued from page* 1)

Members	*Representing*
Joint Director (Chem), RDSO, Lucknow	Railway Board (Ministry of Railways
Assistant Chemist & Metallurgist, N. E. Rly, Gorakhpur (*Alternate*)	
Shri M. S. Krishnan	Bhabha Atomic Research Centre, Bombay
Shri V. N. Lambu	Ion Exchange (India) Ltd, Bombay
Shri M. S. Bidikar (*Alternate*)	
Shri S. Mahadevan	Bharat Heavy Electricals Ltd, Hyderabad
Shri S. B. Kapur (*Alternate* I)	
Shri C. R. Ranganadhan (*Alternate* II)	
Shri V. K. Malik	All India Distillers' Association, New Delhi
Shri K. Suriyanarayanan (*Alternate*)	
Shri K. Manivannan	Director of Industries, Government of Haryana, Chandigarh
Shri S. M. Mehta	Indian Chemical Manufacturers' Association, Calcutta
Shri Mangal Singh (*Alternate*)	
Shri S. K. Mitra	West Bengal Prevention & Control of Water Pollution Board, Calcutta
Municipal Analyst	Municipal Corporation of Greater Bombay
Shri D. V. S. Murthy	M. P. State Prevention & Control of Water Pollution Board, Bhopal
Member-Secretary (*Alternate*)	
Dr V. Sreenivasa Murthy	Central Food Technological Research Institute (CSIR), Mysore
Shri M. S. Subba Rao (*Alternate*)	
Shri S. K. Neogi	Institution of Public Health Engineers, India, Calcutta
Dr M. Banerjee (*Alternate*)	
Dr V. Pachaiyappan	The Fertilizer Association of India, New Delhi
Dr R. N. Trivedi (*Alternate*)	
Shri R. Paramasivam	National Environmental Engineering Research Institute (CSIR), Nagpur
Shri M. V. Nanoti (*Alternate*)	
Shri S. C. Pillai	Indian Institute of Science, Bangalore
Shri Raj Kumar	U. P. Water Pollution Prevention & Control Board, Lucknow
Shri V. P. Gupta (*Alternate*)	
Shri B. B. Rao	Ministry of Works & Housing
Dr I. Radhakrishnan (*Alternate*)	
Shri S. Hanmanth Rao	Karnataka State Board for Prevention & Control of Water Pollution, Bangalore
Shri M. R. Sethumadhava Rao (*Alternate*)	
Shri K. Sreedhara Rao	Central Electricity Authority, New Delhi
Shri B. S. Murti (*Alternate*)	
Shri B. V. Rotkar	Central Board for the Prevention & Control of Water Pollution, New Delhi
Dr K. R. Ranganathan (*Alternate*)	
Shri K. Rudrappa	Engineers India Ltd, New Delhi
Shri S. N. Chakrabarti (*Alternate*)	

(***Continued on page*** 16)

Indian Standard

GUIDE FOR TREATMENT AND DISPOSAL OF EFFLUENTS OF VISCOSE RAYON INDUSTRY

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 28 February 1980, after the draft finalized by the Water Sectional Committee had been approved by the Chemical Division Council.

0.2 The rayon industry falls under the group of chemical industries concerned with the manufacture of artificial and synthetic textile fibres. Production of rayon started more than two decades ago and to date there are about ten rayon factories in the country producing 250 tonnes daily of viscose rayon. Their gross annual production is about 90 000 tonnes.

0.3 Rayon is manufacturerd by three different chemical processes, namely the viscose process, the cellulose acetate process, and the cuprammonium process. In India most of the units produce viscose rayon. This guide relates to the treatment and disposal of viscose rayon effluents.

0.3.1 In the case of those units which produce rayon grade pulp according to conventional pulping processes, IS : 5061 (Part I)-1978* shall also apply.

0.4 Considerable work has been done in this country and abroad on proper treatment and disposal of these effluents and information and data on the subject are now available. A list of relevant references is given in Appendix A for information. These data and information have formed the basis for the preparation of this standard. While realizing that any effluent treatment process has the inherent scope for being further improved, the Committee responsible for the preparation of this standard has given careful consideration to the feasibility of the methods cited in literature and has been of the view that effective measures can now be taken by the industry for abatement of pollution. It is hoped that public health authorities and other agencies concerned with water pollution control in the country will find this standard useful.

---

*Guide for treatment and disposal of effluents of pulp, paper and board industries: Part I For mills with chemical recovery systems (*first revision*).

0.5 The volume of effluent and its pollution load vary considerably from plant to plant. These variations are due to various causes, principal among which are housekeeping, condition of plant and machinery, mode of their operation, and water use. In view of this, the Committee has refrained from incorporating in this standatd cost figures of a treatment plant based on any particular process. It is intended that each plant will select the treatment process best suited to its local conditions.

0.6 The object of this standard is to provide guidelines to viscose rayon units for treatment of effluents. The standard does not seek to provide detailed information on the working of a unit or on the designing and operation of the effluent treatment plant. Further, the methods recommended for adoption have been selected taking into consideration the practicability of thier adoption by the industry. When better and more economic methods of treatment become available, revision of this standard will be taken up.

0.7 It is recommended that plant located near the sea may preferably discharge their effluents into the marine coastal areas rather than into inland surface water. The extent of pollution of marine coastal areas permitted by discharge of effluents is laid down in IS : 7967-1976*.

0.8 The extent of pollution of inland surface waters permitted by discharge of effluents is laid down in IS : 2296-1974†. The following Indian Standards lay down tolerance limits for industrial effluents:

IS : 2490 (Part I)-1974 Tolerance limits for industrial effluents discharged into inland surface waters: Part I General limits (*first revision*)

IS : 3306-1974 Tolerance limits for industrial effluents discharged into public sewers (*first revision*)

IS : 3307-1977 Tolerance limits for industrial effluents discharged on land for irrigation purposes (*first revision*)

IS : 7968-1976 Tolerance limits for industrial effluents discharged into marine coastal areas

0.9 Methods of sampling and test for industrial effluents are covered in IS : 2488 (Part I)-1966‡, IS : 2488 (Part II)-1968‡, IS : 2488 (Part III)-1968‡, IS : 2488 (Part IV)-1974‡ and IS : 2488 (Part V)-1976‡.

---

*Criteria for controlling pollution of marine coastal areas.

†Tolerance limits for inland surface waters subject to pollution (*first revision*).

‡Methods of sampling and test for industrial effluents, Parts I to V.

1. SCOPE

1.1 This standard covers methods of treatment and disposal of effluents of viscose rayon industry. It is a compilation of available data and information on sources, nature, volumes and pollutional effects of the effluents, ways of waste prevention and methods of their treatment and disposal.

2. DESCRIPTION OF MANUFACTURING PROCESS

2.1 Plant Layout — The layout of a modern viscose rayon plant consists of the following:

a) An acid plant for producing sulphuric acid,

b) Carbon disulphide plant,

c) The viscose processing units,

d) Water treatment plant and softening plant, and

e) Boiler house.

2.2 Raw Materials — The raw materials used in the manufacture of viscose rayon consist of cellulose derived from wood pulp or cotton and various process chemicals. The average requirements of the main raw materials to produce one tonne of viscose rayon are as follows:

Sl No.	*Raw Material*	*Requirement*, kg
i)	Cellulose (say wood pulp)	1 000
ii)	Caustic soda	700
iii)	Sulphuric acid	1 100
iv)	Carbon disulphide	300
v)	Zinc	10 to 14

2.3 Process — The basic raw material in the manufacture of viscose rayon is alpha cellulose derived from either wood pulp or cotton linters. The cellulose is converted into alkali cellulose by steeping the raw material in a solution of caustic soda (18 to 20 percent *m/v*) to dissolve the hemicellulose. The alpha cellulose remains insoluble. The excess alkali is squeezed out and recycled. The alkali cellulose is allowed to ripen and then converted to cellulose xanthate by treatment with carbon disulphide. The xanthate is subsequently dissolved in dilute caustic soda solution (1·7 to 2·5 percent *m/v*) to give a solution of proper viscosity. The resulting solution, known as viscose, is separated by filter pressing, deaerated and stored under controlled conditions. The viscose is extruded under pressure into fine jets, through numerous spinnerets into spinning bath containing dilute sulphuric acid (8 to 10 percent *m/v*), zinc sulphate (0·5 to 1 percent *m/v*), and certain other chemicals which are essential to the spinning process.

2.3.1 The spun yarn is first washed free of acid with copious water and then washed free of sulphur which is precipitated on it during its formation by treatment with an alkaline sodium sulphide solution. This is followed by washing with copious volume of water. It is then bleached, washed with dilute acid solution and detergents. The yarn passes through a final stage of finishing and drying and is then conditioned to requisite moisture content and packed for despatch.

3. SOURCES, QUANTITIES AND CHARACTERISTICS OF EFFLUENTS

3.1 Sources

3.1.1 *Carbon Disulphide Plant* — Mostly in the form of cooling and condensate waters.

3.1.2 *Acid Plant* — cooling and condensate waters.

3.1.3 *Alkaline Waste Streams* — from dialysers, ripening and deaerating vessels, filter presses from desulphurizing process and washing operations.

3.1.4 *Acidic Wastes* — derived mainly from the revolving buckets of spinning machines, spin bath make-up tanks, evaporators and washing processes.

3.1.5 *Bleaching Process Wastes* — combined waste stream from bleaching and antichlor wastes.

3.1.6 *Miscellaneous Wastes* — from spills and leaks, floor washings, water treatment plant and sanitary wastes.

3.1.7 The acidic and alkaline waste streams constitute the bulk of the waste water and its pollution load from a viscose rayon plant. The process flow sheet and the sources of the waste waters are shown in Fig. 1.

3.2 Quantity — The quantity of waste water discharged varies from one plant to another. Generally rayon factories which produce their own wood pulp contribute a larger volume of effluents. The waste volume depends upon the size of the unit, its production, availability of water and its usage as shown in Table 1.

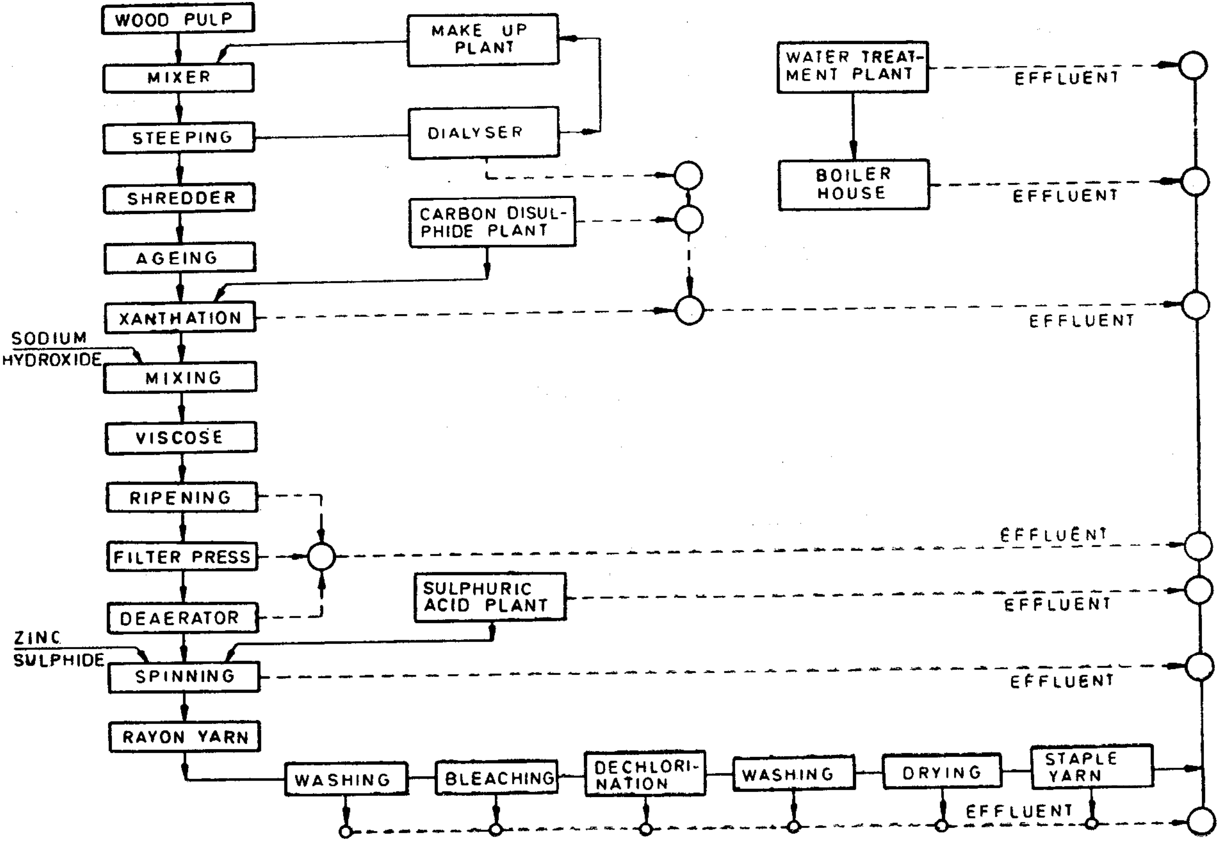

FIG. 1 PROCESS FLOW SHEET FOR VISCOSE RAYON INDUSTRY

TABLE 1 DATA ON VOLUME OF WASTE WATER

(*Clause* 3.2)

PLANT No.	DAILY PRODUCTION	WASTE WATER DISCHARGED DAILY	WASTE VOLUME PER TONNE OF PRODUCT
(1)	(2)	(3)	(4)
	t/day	m^3/day	m^3/t
1	10	12 700	1 273
2	150	90 000	600
3	16	5 000	350
4	10	18 000 to 21 600	1 800
5	40	46 000	1 000
Mean			1 005

3.2.1 The pattern of waste discharge in a rayon factory is more or less uniform in each shift as the sequence of operation is identical and the water usage is continuous.

3.3 Characteristics — The process waste waters consist mostly of various chemicals used like caustic alkali, sulphuric acid, sulphides, traces of sulphur and zinc. The organic constituents of the wastes are mostly in the form of hemicelluloses. The characteristics of the acidic and alkaline waste waters are shown in Tables 2A and 2B.

TABLE 2A CHARACTERISTICS OF ACIDIC PROCESS WASTES

SL No.	CHARACTERISTIC	RANGE
(1)	(2)	(3)
i)	*p*H value	1·0 to 2·0
ii)	Total solids, mg/l	8 900 to 32 900
iii)	Total dissolved solids, mg/l	8 892 to 31 950
iv)	Suspended solids, mg/l	70 to 2 210
v)	Total volatile solids, mg/l	3 226 to 6 826
vi)	Dissolved volatile solids, mg/l	3 376 to 5 606
vii)	Acidity (as $CaCO_3$), mg/l	2 200 to 7 700
viii)	Chemical oxygen demand, mg/l	390 to 790
ix)	Zinc (as Zn), mg/l	181 to 315
x)	Sulphate (as SO_4), mg/l	8 400 to 32 188

TABLE 2B CHARACTERISTICS OF ALKALINE PROCESS WASTES

(*Clause* 3.3)

SL No.	CHARACTERISTICS	RANGE
(1)	(2)	(3)
i)	*p*H value	9·0 to 10·7
ii)	Alkalinity (as $CaCO_3$), mg/l	310 to 790
iii)	Total solids, mg/l	1 480 to 2 940
iv)	Total dissolved solids, mg/l	960 to 2 260
v)	Suspended solids, mg/l	236 to 680
vi)	Chemical oxygen demand, mg/l	154 to 1 160
vii)	Chloride (as Cl), mg/l	148 to 242
viii)	Sulphate (as SO_4), mg/l	267 to 1 315

3.3.1 *Acidic Wastes* — The acidic waste water is a mixture of the spent spin bath, make up tanks and spinning machines, evaporator and washings. It has a low *p*H, high acidity, dissolved solids, sulphate and zinc. The sulphate is in the form of sodium sulphate and as sulphuric acid. The organic content of the acidic wastes is, however, quite low as seen from the biochemical oxygen demand and chemical oxygen demand values. Not withstanding its small volume this waste consist of the strongest and most highly toxic component of rayon wastes.

3.3.2 *Alkaline Wastes* — The alkaline waste water has a high *p*H, a variable total dissolved solids and suspended solids.

3.3.3 *Characteristics of Combined Wastes* — The characteristics of the composite mill wastes from a selected group of rayon manufacturing units in the country are shown in Table 3. The combined waste is generally acidic and has high total dissolved solids and low biochemical and chemical oxygen demand. Zinc is present in variable concentration, often exceeding the permissible limits. The sulphate content is high but the chloride content is low.

3.4 Pollution Load — The pollution load contributed by viscose rayon wastes is mostly in the form of inorganic chemicals like sulphuric acid, sodium sulphate, zinc sulphate and sodium sulphide. The organic constituent of the pollution load is however quite low as will be seen from the low biochemical and chemical oxygen demand of the waste water. The pollution load contributed by some of the major rayon units in the country is shown in Table 4.

TABLE 3 CHARACTERISTICS OF COMBINED EFFLUENTS

(*Clause* 3.3.3)

SL No.	CHARACTERISTICS	RANGE
(1)	(2)	(3)
i)	Waste volume per tonne of product, m^3/day	350 to 1 800
ii)	*p*H value	2·8 to 7·3
iii)	Acidity (as $CaCO_3$) mg/l	160 to 1 000
iv)	Alkalinity (as $CaCO_3$), mg/l	50 to 300
v)	Total solids, mg/l	1 170 to 6 500
vi)	Total dissolved solids, mg/l	1 100 to 1 200
vii)	Suspended solids, mg/l	70 to 300
viii)	Biochemical oxygen demand (5 days at 20°C), mg/l	50 to 380
ix)	Chemical oxygen demand, mg/l	210 to 280
x)	Sulphate (as SO_4), mg/l	700 to 6 690
xi)	Chloride (as Cl), mg/l	37 to 200
xii)	Zinc (as Zn), mg/l	2 to 18

4. POLLUTIONAL EFFECTS

4.1 The effluents discharged by a viscose rayon factory may have adverse effects on the receiving streams in many ways.

4.1.1 *Effect of Acidic Wastes* — The free mineral acids present in the wastes are objectionable in a stream on account of corrosive action on metal, concrete structures and pumps. Acids will lower the *p*H of the stream and liberate hydrogen sulphide from bottom deposits. There will be a suppression of biochemical activity in the stream and retardation of bacterial self purification. Increase in hydrogen ion concentration (lowering of *p*H value) will be injurious to fish life through precipitation and coagulation of the secretion of the gills and gill membranes.

4.1.2 *Effects of Alkaline Wastes* — The alkaline wastes having *p*H greater than 9·0 can be lethal to all forms of aquatic life.

TABLE 4 POLLUTION LOAD FROM VISCOSE RAYON MILLS

(*Clause* 3.4)

UNIT No.	PRODUCTION	WASTE VOLUME	POLLUTION LOAD				
			Biochemical Oxygen Demand	Chemical Oxygen Demand	Suspended Solids	Mineral Acids	Zinc
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	t/day	m^3/day	kg/day	kg/day	kg/day	kg/day	kg/day
1)	10	12 700	a) 465	3 560	1 270	2 032	140
			b) 46·5	356	127	203	14
2)	150	90 000	a) 3170	15 750	18 000	27 300	1 180
			b) 21	105	120	182	8
3)	16	5 000	a) 375	—	1 500	—	15
			b) 23·5	—	93	—	0·8
4)	10	18 000 to 21 600	a) 1 600	—	1 400	20 000	100
			b) 160	—	140	2 000	10
5)	40	46 000	a) 17 500	—	6 440	—	230
			b) 437	—	161	—	6

a) = Gross load

b) = Pollution load per tonne of product

The pollution equivalent per tonne of product of the wastes discharged by a rayon factory is as follows:

Biochemical oxygen demand = 1 380

Suspended solids = 853

4.1.3 *Toxic Effects due to Zinc* — Zinc is highly toxic to fish. The lethal concentration of zinc to fish life varies according to the species. The concentration of zinc is the combined rayon wastes is often greater than the threshold limits.

4.1.4 *Oxygen Depletion* — Depletion of dissolved oxygen in the streams may result from the organic substances and sulphide present in the waste.

5. METHODS OF TREATMENT

5.1 Treatment of rayon factory wastes consists of the following.

5.1.1 Reduction in waste strength by recovery of process chemicals.

5.1.2 Equalization of acidic and alkaline waste streams for self neutralization and supplemented by treatment with either acid or alkali for *p*H correction to the desired limits.

5.1.3 *Primary Treatment*

5.1.4 *Secondary Treatment*

5.2 Reduction of Waste Strength — The first essential step towards treatment of the wastes consists in the reduction of waste strength by recovery of process chemicals. The acidic and alkaline process wastes are segregated from each other and are treated independently for by-product recovery. From the alkaline wastes caustic soda is recovered by dialysis and recycled. From the highly concentrated acidic spent spinbath solution and washings, sodium sulphate and zinc can be recovered. Sodium sulphate is obtained by concentration, evaporation and crystallization. Recovery of zinc is made by either chemical precipitation with caustic soda at a critical *p*H of 9·0, as zinc hydroxide, followed by sedimentation and filtration or by ion exchange process. The chemical recovery is an integral point of the unit processes in the manufacture of viscose rayon.

5.3 Equalization of the Waste — The acidic and alkaline wastes are mixed in an equalization tank and requisite amount of lime is added for *p*H correction.

5.4 Primary Treatment — The primary treatment of the combined waste stream consists of the following steps.

5.4.1 Screening of the waste for removal of coarse floating matter.

5.4.2 Removal of coarse gritty materials.

5.4.3 Removal of suspended and settleable solids by settling.

5.5 Secondary Treatment — The treatment of the wastes for reduction in biochemical oxygen demand can be carried out in a conventional aerobic waste treatment system. The biochemical oxygen demand of the combined waste is quite low (50 to 100 mg/l). In some of the viscose rayon factories wherein rayon grade wood pulp is also produced, the waste stream is likely to have a high biochemical oxygen demand (300 to 700 mg/l). Even so the wastes could be successfully treated by conventional aerobic systems of which the trickling filter with recirculation has been found to be most suitable by the rayon industry in UK and USA. The wastes can also be treated more economically by low cost waste treatment systems, preferably the aerated lagoon. The composite wastes are deficient in nitrogen and phosphorus and they can be easily provided in the system as supplementary nutrients. More advantageously the viscose rayon process wastes can also be treated in combination with domestic sewage.

6. METHODS RECOMMENDED FOR ADOPTION IN INDIA

6.1 Reviewing the methods outlined in **5**, it is recommended that a scheme for complete treatment of composite effluents from viscose rayon industries would consist of the following.

6.1.1 Segregation of the various process waste streams.

6.1.2 Equalization of the acidic and alkaline waste streams for self neutralization with provision for further treatment with lime if *p*H correction to the requisite degree is found necessary.

6.1.3 Primary treatment for removal of floating matter, oil and grease and suspended and settleable solids.

6.1.4 Secondary aerobic treatment for biochemical oxygen demand reduction either by conventional trickling filter and activated sludge process or low cost systems like an aerated lagoon or oxidation pond.

6.2 It may be stated that the degree of treatment to be provided by a particular factory will be determined by the ultimate disposal of the effluents into the environment, that is, discharge into public sewers, surface streams or directly into the sea.

6.3 For discharge into municipal sewers, the treatment may be limited to the primary stage only; and for discharge into inland surface waters, secondary treatment for biochemical oxygen demand reduction will be necessary. The degree of dilution available in the stream will be yet another factor to be considered.

6.4 For disposal in the marine environment, the degree of treatment will be determined by the prescribed standards of effluent quality. In view of the considerable degree of dilution available, the effluents from viscose rayon manufacture may be discharged into the sea after primary treatment. This would require a well designed submarine outfall system with suitable arrangements for efficient diffusion and dispersion of the effluents from the outfall system into the sea.

6.5 The secondary treatment consists of the following:

a) Lagooning;
b) Coventional aerobic treatment including trickling filter, activated sludge process; and/or
c) Low cost waste treatment like aerated lagoon and the oxidation pond.

6.5.1 Flow sheet of a treatment plant is shown in Fig. 2.

APPENDIX A

(*Clause* 0.4)

REFERENCES

1. CHAKRABARTY (R N) and SAXENA (K L). Studies on viscose rayon wastes. *Environmental Health.* 112-22, 8, 1966.

2. CHAKRABARTY (R N) *et al.* Studies on recovery of zinc from viscose rayon wastes. *Environmental Health.* 1, 9, 296, 1967.

3. BHAKUNI (T S) *et al.* Recovery of zinc from spinning bath wastes of viscose rayon factory by ion exchange process. *ibid*, 327.

4. KHARE (G K) and SASTRI (C A). Studies on characteristics and pollutional effects of viscose rayon wastes. *Environmental Health.* 2, 12, 99-109, 1970.

5. KANTAWALLA(D) and TOMLINSON (H D). *Water and Sewage Works.* 192, 1964.

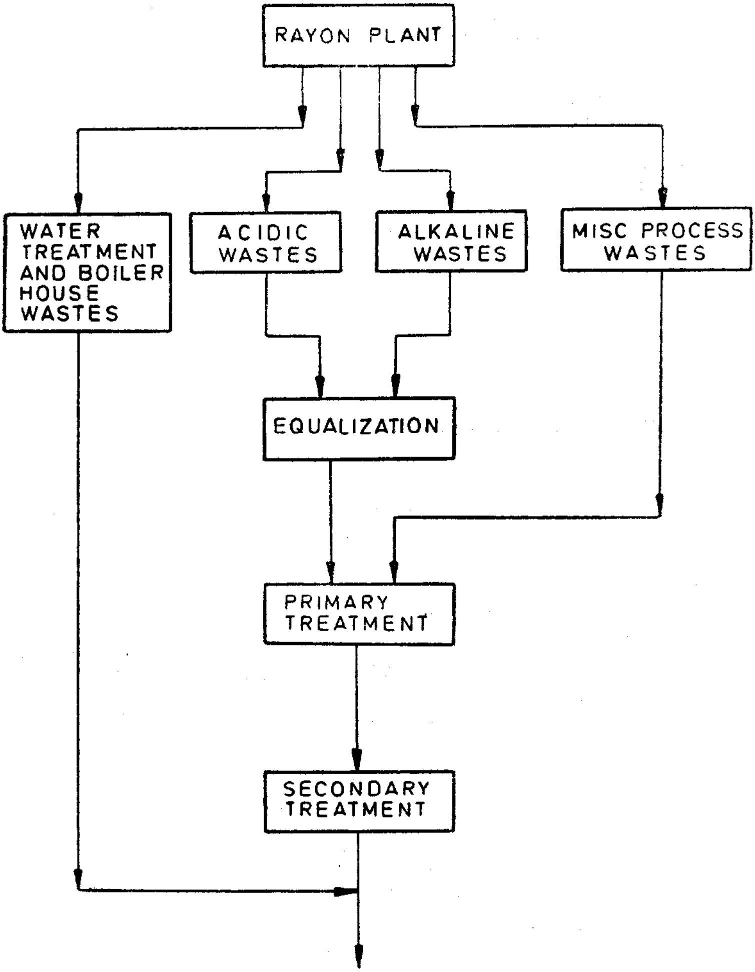

Fig. 2 Flow Sheet for Treatment of Viscose Rayon Wastes

(*Continued from page* 2)

Members	*Representing*
Shri M. L. Shah	Bombay Chamber of Commerce & Industry, Bombay
Shri R. M. Shah	Tata Chemicals Ltd, Bombay
Shri R. K. Gandhi (*Alternate*)	
Shri D. R. Singal	Punjab State Board for the Prevention & Control of Water Pollution, Patiala
Shri Qimat Rai (*Alternate*)	
Dr (Smt) S. M. Vachha	Director of Health Services, Government of Maharashtra, Bombay
Dr G. M. Saxena, Director (Chem)	Director General, ISI (*Ex-officio Member*)

Secretary
Shri N. K. Sharma
Deputy Director (Chem), ISI

Waste Treatment Methods Subcommittee, CDC 26 : 1

Convener	
Shri A. Raman	National Environmental Engineering Research Institute (CSIR), Nagpur
Members	
Shri B. V. S. Gurunathrao (*Alternate* to Shri A. Raman)	
Shri D. S. Bhargava	Central Board for the Prevention & Control of Water Pollution, New Delhi
Dr H. S. Matharu (*Alternate*)	
Shri M. S. Bidikar	Ion Exchange (India) Ltd, Bombay
Shri V. V. Joshi (*Alternate*)	
Dr R. N. Chakrabarty	Universal Enviroscience Pvt Ltd, New Delhi
Chief Water Analyst, King Institute, Madras	Director of Public Health, Government of Tamil Nadu, Madras
Shri L. M. Choudhry	Haryana State Board for the Prevention & Control of Water Pollution, Chandigarh
Shri M. L. Prabhakar (*Alternate*)	
Dr D. Choudhury	Indian Chemical Manufacturers' Association, Calcutta
Shri V. K. Dikshit (*Alternate*)	
Director (C. S.&M. R. S)	Central Electricity Authority, New Delhi
Shri N. C. Rawal (*Alternate*)	
Shri B. K. Dutta	The Fertilizer (Planning & Development) India Ltd, Sindri
Shri G. S. Ray (*Alternate*)	

(*Continued on page* 17)

(*Continued from page* 16)

Members	*Representing*
Shri K. R. Krishnaswami	Madras Fertilizers Ltd, Madras
Shri A. K. Majumdar	Geo-Miller & Co Pvt Ltd, Calcutta
Shri S. V. Mani	Greaves Cotton & Co Ltd, Bombay
Shri S. R. Luthra (*Alternate*)	
Shri V. S. More	Indian Oil Corporation Ltd (Refineries & Pipelines Division), New Delhi
Shri K. Vaithalingam (*Alternate*)	
Shri D. V. S. Murthy	M. P. State Prevention & Control of Water Pollution Board, Bhopal
Dr G. K. Khare (*Alternate*)	
Shri R. Natarajan	Hindustan Dorr-Oliver Ltd, Bombay
Shri Amit S. Desai (*Alternate*)	
Dr V. Pachaiyappan	The Fertilizer Association of India, New Delhi
Dr R. N. Trivedi (*Alternate*)	
Shri A. G. Pandit	Maharashtra Prevention of Water Pollution Board, Bombay
Dr R. Pitchai	College of Engineering, Madras
Shri Raj Kumar	U. P. Water Pollution Prevention & Control Board, Lucknow
Shri V. P. Gupta (*Alternate*)	
Shri B. B. Rao	Ministry of Works & Housing
Shri T. K. Vedaraman (*Alternate*)	
Shri K. Rudrappa	Engineers India Ltd, New Delhi
Shri S. N. Chakrabarti (*Alternate*)	
Shri D. R. Singal	Punjab State Board for the Prevention & Control of Water Pollution, Patiala
Shri Qimat Rai (*Alternate*)	

Panel for Textile and Allied Industry Wastes, CDC 26 : 1 : 5

Convener	
Shri S. Rajagopalan	National Environmental Engineering Research Institute (CSIR), Nagpur

Members	
Smt I. Jayangouder (*Alternate* to Shri S. Rajagopalan)	
Chief Water Analyst, King Institute, Madras	Director of Public Health, Government of Tamil Nadu, Madras
Shri S. B. De	All India Institute of Hygiene & Public Health, Calcutta
Shri M. D. Dixit	The Bombay Textile Research Association, Bombay
Shri S. A. Tarabadkar (*Alternate*)	
Prof R. S. Mehta	Gujarat Water Pollution Control Board, Gandhinagar
Shri D. V. S. Murthy	M. P. State Prevention & Control of Water Pollution Board, Bhopal
Member-Secretary (*Alternate*)	

(*Continued on page* 18)

(*Continued from page* 17)

Members	*Representing*
Shri R. Natarajan	Hindustan Dorr-Oliver Ltd, Bombay
Shri A. H. Tijoriwala (*Alternate*)	
Shri K. P. Ramakrishna Pillay	The South India Textile Research Association, Coimbatore
Project Engineer (Sewerage)	Bombay Municipal Corporation, Bombay
Deputy Project Engineer (Sewerage) (*Alternate*)	
Shri Kishor K. Sanghani	Ahmadabad Municipal Corporation, Ahmadabad
Dr P. V. Seshadri	National Textile Corporation Ltd, New Delhi
Shri G. V. S. Desikan (*Alternate*)	
Shri J. K. Shah	The Arvind Mills Ltd, Ahmadabad
Shri N. R. Srinivasan	Directorate General of Technical Development, New Delhi
Shri J. M. Tuli	Engineers India Ltd, New Delhi
Shri R. N. Tewari (*Alternate*)	
Shri S. S. Warty	The Silk & Art Silk Mills Research Association, Bombay